

## CLAIMS

What is claimed is:

- 1           1.     A composition comprising:  
2                 a matrix, wherein the matrix exhibits a phase change between about  
3           30° C and about 100° C; and  
4                 a distribution of first interstitial heat transfer structures in the matrix,  
5           including a size range from about 5 micron to about 25 micron, and wherein  
6           the distribution of first interstitial heat transfer structures occupies from  
7           about 5 volume percent to about 95 volume percent of the composition.
- 1           2.     The composition of claim 1, wherein the distribution of first  
2           interstitial heat transfer structures is selected from aluminum, aluminum alloys,  
3           copper, copper alloys, silver, silver alloys, tin, tin alloys, dielectrics, graphite,  
4           carbon fibers and combinations thereof.
- 1           3.     The composition of claim 1, further including a distribution of  
2           second interstitial heat transfer structures, wherein the distribution of second  
3           interstitial heat transfer structures includes a low melting-point metal.
- 1           4.     The composition of claim 1, further including a distribution of  
2           second interstitial heat transfer structures, wherein the distribution of second  
3           interstitial heat transfer structures is present in a greater weight concentration than  
4           the distribution of first interstitial heat transfer structures.
- 1           5.     The composition of claim 1, wherein the matrix is selected from  
2           silicone, an amino epoxy, an acrylate, an olifin resin, a vinyl, an acrylic, a natural  
3           rubber, and a synthetic rubber.

1           6.       The composition of claim 1, wherein the matrix is selected from  
2       silicone, an amino epoxy, an acrylate, an olifin resin, a vinyl, an acrylic, a natural  
3       rubber, and a synthetic rubber, and wherein the wetting agent is present from about  
4       1 to about 25 percent, the matrix is present from about 4 to about 75 percent, and the  
5       interstitial heat transfer structures are present from about 5 to about 95 percent.

1           7.       An article comprising:  
2               a matrix including a first surface and a second surface that is parallel  
3       planar to the first surface, wherein the matrix exhibits a phase change  
4       between about 30° C and about 100° C;  
5               a distribution of first interstitial heat transfer structures in the matrix,  
6       including a size range from about 5 micron to about 25 micron, and wherein  
7       the distribution of first interstitial heat transfer structures occupies from  
8       about 5 volume percent to about 95 volume percent of the composition; and  
9               wherein the first surface is separated from the second surface by less  
10       than or equal to about 30 micron.

1           8.       The article of claim 7, wherein a contiguous interstitial heat transfer  
2       structure path originates at the first surface and terminates at the second surface, and  
3       wherein the contiguous interstitial heat transfer structure path includes four or fewer  
4       interstitial heat transfer structures.

1           9.       The article of claim 7, further including:  
2               a distribution of second interstitial heat transfer structures, wherein a  
3       portion of the distribution of second interstitial heat transfers includes one  
4       interface exposed at least one of the first surface and the second surface, and  
5       one interface exposed to at least one of the distribution of first interstitial  
6       heat transfer structures.

1           10.    The article of claim 7, further including:  
2                   a distribution of second interstitial heat transfer structures, wherein a  
3           portion of the distribution of second interstitial heat transfer structures  
4           includes one interface exposed at least one of the first surface and the second  
5           surface, and one interface exposed to at least one of the distribution of first  
6           interstitial heat transfer structures, and wherein the distribution of second  
7           interstitial heat transfer structures is present in a greater weight concentration  
8           than the distribution of first interstitial heat transfer structures.

1           11.    The article of claim 7, wherein the matrix is selected from silicone,  
2           an amino epoxy, an acrylate, an olifin resin, a vinyl, an acrylic, a natural rubber, and  
3           a synthetic rubber.

1           12.    The article of claim 7, wherein the matrix is selected from silicone,  
2           an amino epoxy, an acrylate, an olifin resin, a vinyl, an acrylic, a natural rubber, and  
3           a synthetic rubber, and wherein the wetting agent is present from about 1 to about  
4           25 percent, the matrix is present from about 4 to about 75 percent, and the  
5           interstitial heat transfer structures are present from about 5 to about 95 percent.

1           13.    A package comprising:  
2                   a die;  
3                   a first heat sink;  
4                   a thermal interface material disposed between the die and the first  
5           heat sink, the thermal interface material including:  
6                   a matrix, wherein the matrix exhibits a phase change between  
7                   about 30° C and about 100° C; and  
8                   a distribution of first interstitial heat transfer structures in the  
9                   matrix, including a size range from about 5 micron to about 25  
10                  micron, and wherein the distribution of first interstitial heat transfer

11 structures occupies from about 5 volume percent to about 95 volume  
12 percent of the composition; and  
13 wherein the die is separated from the first heat sink by less than or  
14 equal to about 30 micron.

1 14. The package of claim 13, further including:  
2 a second heat sink disposed above the first heat sink.

1 15. The package of claim 13, further including:  
2 a second heat sink disposed above the first heat sink; and  
3 a thermal interface material disposed between the first heat sink and  
4 the second heat sink, including:  
5 a second heat sink matrix, wherein the second heat sink  
6 matrix exhibits a phase change between about 30° C and about 100°  
7 C; and  
8 a distribution of first interstitial heat transfer structures in the  
9 second heat sink matrix, including a size range from about 5 micron  
10 to about 1,000 micron, and wherein the distribution of first interstitial  
11 heat transfer structures occupies from about 5 volume percent to  
12 about 95 volume percent of the composition.

1 16. The package of claim 13, wherein the matrix is selected from  
2 silicone, an amino epoxy, an acrylate, an olifin resin, a vinyl, an acrylic, a natural  
3 rubber, and a synthetic rubber.

1 17. The package of claim 13, wherein the matrix is selected from  
2 silicone, an amino epoxy, an acrylate, an olifin resin, a vinyl, an acrylic, a natural  
3 rubber, and a synthetic rubber, and wherein the wetting agent is present from about  
4 1 to about 25 percent, the matrix is present from about 4 to about 75 percent, and the  
5 interstitial heat transfer structures are present from about 5 to about 95 percent.

- 1           18.    The package of claim 13, wherein the die includes a bare die.
- 1           19.    The package of claim 13, wherein the die includes a bare die in a  
2   mobile device.
- 1           20.    A method comprising:  
2                    assembling a package, the package including:  
3                        a die;  
4                        a heat sink; and  
5                        a first thermal interface material disposed between the die and  
6           the heat sink, the first thermal interface material including:  
7                        a matrix, wherein the matrix exhibits a phase change  
8                        between about 30° C and about 100° C; and  
9                        a distribution of first interstitial heat transfer  
10                    structures in the matrix, including a size range from about 5  
11                    micron to about 25 micron, and wherein the distribution of  
12                    first interstitial heat transfer structures occupies from about 5  
13                    volume percent to about 95 volume percent of the  
14                    composition;  
15           removing the first thermal interface material; and  
16           applying a second thermal interface material.
- 1           21.    The method of claim 20, before removing the first thermal interface  
2   material, the method including:  
3                    operating the die under conditions to cause the matrix to change  
4           phase.
- 1           22.    The method of claim 20, wherein removing the thermal interface  
2   material is carried out at a temperature selected from room temperature and a  
3   temperature above room temperature.

1           23.    The method of claim 20, further including:  
2                   a distribution of second interstitial heat transfer structures, wherein  
3           the distribution of second interstitial heat transfer structures includes a low  
4           melting-point metal, the method further including:  
5                   removing the thermal interface material at a temperature of at least  
6           the solidus temperature of the distribution of second interstitial heat transfer  
7           structures.

1           24.    The method of claim 20, wherein removing the thermal interface  
2           material includes removing from a bare die.

1           25.    The method of claim 20, wherein the thermal interface material  
2           includes removing from a bare die in a mobile device.

1           26.    A computing system comprising:  
2                   a die;  
3                   a first heat sink;  
4                   a thermal interface material disposed between the die and the first  
5           heat sink, the thermal interface material including:  
6                   a matrix, wherein the matrix exhibits a phase change between  
7                   about 30° C and about 100° C; and  
8                   a distribution of first interstitial heat transfer structures in the  
9           matrix, including a size range from about 5 micron to about 25  
10          micron, and wherein the distribution of first interstitial heat transfer  
11          structures occupies from about 5 volume percent to about 95 volume  
12          percent of the composition;  
13          wherein the die is separated from the first heat sink by less than or  
14          equal to about 30 micron; and  
15          at least one of an input device and an output device coupled to the  
16          die.

1           27.     The computing system of claim 26, wherein the computing system is  
2 disposed in one of a notebook computer, a desktop computer, a wireless  
3 communicator, a hand-held device, an automobile, a locomotive, an aircraft, a  
4 watercraft, and a spacecraft.

1           28.     The computing system of claim 26, wherein the die is selected from a  
2 data storage device, a digital signal processor, a micro-controller, an application  
3 specific integrated circuit, and a microprocessor.

1           29.     The computing system of claim 26, wherein the die includes a bare  
2 die.

1           30.     The computing system of claim 26, wherein the die includes a bare  
2 die in a mobile device.